

Examining the Impact of LDR and BOPO on ROA through NIM: Evidence from Indonesian Conventional Banks (2014–2023)

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Abstract

This study investigates the influence of the Loan to Deposit Ratio (LDR) and Operating Expenses to Operating Income (BOPO) on Return on Assets (ROA), with Net Interest Margin (NIM) as a mediating variable, in Indonesian conventional banks listed on the Indonesia Stock Exchange over the 2014–2023 period. Using a quantitative approach and path analysis, the study employs panel data extracted from annual financial reports and processed with STATA 17. The findings indicate that LDR has a significant positive effect on NIM, while BOPO negatively and significantly affects NIM. In terms of profitability, LDR shows an insignificant negative influence on ROA, whereas BOPO exerts a strong negative and significant effect. Meanwhile, NIM positively and significantly impacts ROA. Mediation analysis reveals that NIM mediates the relationships between LDR and ROA, and between BOPO and ROA, with Sobel test results confirming the significance of these indirect effects. These results underscore the critical role of NIM in enhancing profitability and mitigating the adverse effects of inefficiencies. The study emphasizes the strategic importance of optimizing loan allocation and cost efficiency to improve bank performance. The findings offer practical implications for banking management in designing targeted strategies that prioritize operational efficiency and margin optimization to strengthen profitability amidst regulatory changes and increasing competition in the banking sector.

1. Introduction

The banking sector plays a pivotal role in the Indonesian economy as a financial intermediary that mobilizes public funds and allocates them through credit distribution. This intermediary function is not only essential for driving economic growth but also for maintaining the stability of the national financial system (Mishkin, 2019). In the Indonesian context, the banking industry has demonstrated resilience against various economic shocks, such as the 1997–1998 Asian financial crisis and the 2008 global financial crisis. However, maintaining profitability remains a persistent challenge amidst dynamic global economic conditions. Suryanto (2016) notes that the stability of Indonesia's banking system has improved significantly following the implementation of the Indonesian Banking Architecture (API), although continuous reforms are still needed to address the growing complexities of the financial sector.

Robust and efficient banking performance is crucial for preserving financial system stability and supporting sustainable

economic development. In a volatile and increasingly competitive global environment, a bank's ability to adapt and sustain profitability is becoming more critical. Profitability is often measured by Return on Assets (ROA), an indicator that reflects a bank's ability to generate income from its total assets. According to Dewi et al. (2016), ROA serves as a comprehensive performance metric that captures management effectiveness in utilizing assets to generate profits, making it a key concern for stakeholders such as investors, regulators, and the public.

To understand the determinants of bank profitability, numerous studies have investigated financial ratios such as the Loan to Deposit Ratio (LDR) and Operating Expenses to Operating Income (BOPO). LDR reflects the extent to which collected deposits are converted into credit, thereby indicating a bank's liquidity and the effectiveness of its intermediation role. Sudarmawanti and Pramono (2017) find that LDR has a positive effect on ROA, suggesting that effective credit allocation enhances bank profitability.



Conversely, BOPO serves as a proxy for operational efficiency, showing the proportion of operating expenses relative to income. Hakim and Sugianto (2018), in their study on Islamic commercial banks in Indonesia, confirm that BOPO significantly affects ROA, emphasizing the importance of cost control in enhancing financial performance.

While LDR and BOPO are known to influence ROA, their impact may be mediated by other financial indicators—particularly the Net Interest Margin (NIM). NIM represents a bank's ability to generate net interest income and reflects the efficiency of managing asset-liability spread. As such, NIM can act as a mediating variable between LDR, BOPO, and ROA. Raharjo et al. (2014) show that NIM has a significant positive effect on ROA, highlighting the relevance of managing interest margin in boosting profitability.

Despite several studies exploring the direct relationships between these variables, the mediating role of NIM remains underexplored in the context of Indonesia's conventional banking sector. Moreover, rapid changes in financial market dynamics, evolving regulations, technological innovation, and shifting consumer behavior—particularly due to the rise of fintech—further complicate the interplay of these factors. Addressing this complexity is critical for developing strategies to enhance financial resilience and performance.

This study focuses on conventional banks listed on the Indonesia Stock Exchange, which represent a significant portion of the national banking sector and provide access to transparent, publicly available financial data. Siringoringo (2012) emphasizes the value of focusing on listed commercial banks to better understand the dynamics of banking performance in Indonesia.

Therefore, this study aims to fill the research gap by analyzing the influence of LDR and BOPO on ROA, with NIM as a mediating variable. Using data from 2014 to 2023, the research spans multiple economic cycles, including the COVID-19 pandemic, thus offering

a comprehensive view of the banking sector's adaptability and resilience across different economic environments.

2. Literature Review

2.1 *Conventional Banks*

Conventional banks are financial institutions that serve as intermediaries between surplus and deficit economic agents. According to Law No. 10 of 1998 concerning Banking, a bank is a business entity that collects funds from the public in the form of deposits and channels them to the public in the form of credit and/or other financial instruments to improve societal welfare. These banks operate under an interest-based system, providing returns on customer deposits and charging interest on credit disbursed.

Kasmir (2014) highlights two primary functions of conventional banks: the **intermediation function** (channeling funds from surplus to deficit units) and the **transmission function** (facilitating financial transactions). Modern banking operations require risk analysis, liquidity management, and portfolio diversification to perform these functions effectively. Budisantoso and Nuritomo (2014) further classify conventional banking activities into **funding, lending, and service provision**, including services such as credit, savings, remittances, and letters of credit.

Darmawi (2012) argues that globalization and digital transformation compel conventional banks to innovate and adapt continuously. The emergence of fintech and digital banking presents both a challenge and an opportunity, pushing conventional banks to enhance operational efficiency, adopt advanced technology, and strengthen risk management practices.

2.2 *Loan to Deposit Ratio (LDR)*

The Loan to Deposit Ratio (LDR) is a key liquidity indicator that measures a bank's ability to convert deposits into credit. It is calculated by dividing the total amount of loans by the total deposits. According to Bank Indonesia

Regulation No. 15/15/PBI/2013, the ideal LDR range is 78%–92%, ensuring a balance between liquidity risk and intermediation effectiveness.

Dendawijaya (2009) explains that a high LDR may indicate aggressive lending, which can pose liquidity risks, while a low LDR may suggest underutilized funds and weak intermediation. Hence, LDR is a crucial metric for evaluating a bank's credit policy and liquidity strategy.

2.3 Operating Expenses to Operating Income (BOPO)

BOPO is a financial efficiency ratio comparing operational expenses with operational income. A lower BOPO ratio indicates higher efficiency, while a higher ratio signals poor cost management. Kasmir (2014) states that this ratio reflects a bank's ability to control expenses related to interest, labor, and administration relative to its operating income.

According to Riyadi (2006), Bank Indonesia considers a BOPO ratio below 90% as optimal. Exceeding this threshold implies inefficiency. Pandia (2012) further suggests that a high BOPO ratio contributes to operational risk, potentially affecting profitability and performance sustainability.

2.4 Net Interest Margin (NIM)

Net Interest Margin (NIM) measures the profitability of a bank's intermediation activities, calculated as net interest income divided by average earning assets. A higher NIM reflects a greater ability to generate profit from interest-based activities (Taswan, 2010).

Dendawijaya (2009) notes that NIM is influenced by market structure, credit risk, operational cost, and interest rate spread. While a higher NIM typically suggests stronger performance, it may also indicate inefficiency if the interest spread is excessively large. Hidayat et al. (2012) confirm the significant positive impact of NIM on profitability in Indonesian banking, though excessively high NIM can elevate intermediation costs and hinder broader economic growth.

2.5 Return on Assets (ROA)

Return on Assets (ROA) is a profitability ratio that indicates how effectively a bank uses its assets to generate net income. It is calculated by dividing net income by total assets (Hanafi & Halim, 2016). A higher ROA suggests efficient asset utilization and stronger financial performance.

Sudana (2011) and Hery (2015) argue that ROA is a critical indicator for assessing management efficiency in asset utilization. Dendawijaya (2009) and Riyadi (2006) both emphasize ROA as a key metric for evaluating a bank's overall profitability and strategic performance in the financial sector.

3. Research Methods

3.1 Type of Research

This study employs a **quantitative research approach**, which focuses on measuring and analyzing causal relationships among variables through the use of statistical techniques. Quantitative research utilizes numerical data and objective methods to test pre-formulated hypotheses or theoretical models. According to Sugiyono (2017), quantitative methods are rooted in positivist philosophy, typically involving specific populations or samples, data collection through structured instruments, and statistical data analysis aimed at hypothesis testing.

3.2 Data Source

This study utilizes **secondary data** obtained from the officially published **annual reports** of conventional banks over a ten-year period, from 2014 to 2023. Annual reports are publicly available documents that serve as a form of accountability and transparency for stakeholders, containing comprehensive financial and non-financial information. The choice of annual reports as a data source is based on their reliability, completeness, and accessibility. These reports were retrieved from the official websites of the respective banks and from the **Indonesia Stock Exchange (IDX)** portal.

3.3 Data Analysis Method

The analytical method used in this research is path analysis, a statistical technique designed to examine both direct and indirect relationships between independent and dependent variables, including the role of mediating variables. Path analysis is particularly useful in assessing structural relationships in a causal model and is appropriate for hypothesis-driven quantitative studies.

This study uses panel data, which combines cross-sectional and time-series data, allowing for the control of individual heterogeneity over time. Data processing and analysis were conducted using STATA version 17, a robust statistical software package for econometric modeling.

The basic equation of path analysis is as follows:

$$Z = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots \dots \dots (1)$$

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 Z + \dots \dots \dots (2)$$

Where:

- **Y** = Return on Assets (ROA)
- **X₁** = Loan to Deposit Ratio (LDR)
- **X₂** = Operating Expenses to Operating Income (BOPO)
- **Z** = Net Interest Margin (NIM)
- **α** = Constant term
- **β₁, β₂, β₃** = Regression coefficients of independent variables

To test the significance of the mediation effect in the path analysis model, the Sobel Test is carried out. The Sobel Test is used to determine whether the mediation effect (indirect path) is significant, by calculating how much influence the independent variable has on the dependent variable that is channeled through the mediation variable. The basic formula used in the Sobel test is as follows:

$$Z = \frac{a \cdot b}{\sqrt{b^2 \cdot S_a^2 + a^2 \cdot S_b^2}}$$

Where:

- **a** = Regression coefficient of the independent variable on the mediator
- **b** = Regression coefficient of the mediator on the dependent variable
- **S_a** = Standard error of coefficient **a**
- **S_b** = Standard error of coefficient **b**.

In addition, the Sobel test can also be calculated via the following website: <https://quantpsy.org/sobel/sobel.htm>

4. Results and Discussion

4.1 Research result

Estimation model selection

Table 1. Chow test

Statistik	Nilai
R-squared (Within)	0.3994
R-squared (Between)	0.9592
R-squared (Overall)	0.7150
Jumlah Observasi (Obs)	80
Jumlah Grup	8
Observasi per Grup	min = 10, max = 10, avg = 10
F(3, 69)	15.29
Prob > F	0.0000
corr(u _i , X _b)	-0.2514
σ _u (Sigma-u)	0.18053381
σ _e (Sigma-e)	0.06673027
ρ (Rho - Varian karena efek tetap)	0.87940281

Based on the results of the chow test above, it shows that the probability value is 0.5585 > 0.05, so it can be concluded that the selected model is CEM. Because the selected model is CEM, the hausman test does not need to be done again, just go directly to the LM Test.

Table 2. Lagrangian multiplier test (LM Test)

Komponen	Varians (Var)	Standar Deviasi (SD = √Var)
y (Total)	1.230784	1.109407
e (Residual)	0.3685362	0.6070718
u (Unit)	0.0135898	0.1165755
Uji Statistik		Nilai



Test: Var(u) = 0	
Nilai Chi-bar ² (1)	0.27
Probabilitas (Prob > chibar ²)	0.3007
Model yang dipilih	CEM (Common Effect Model)

Based on the results of the LM Test above, it shows that the probability value is $0.3007 > 0.05$, so it can be concluded that the selected model is CEM. Based on the results of the Chow Test and LM Test, it can be concluded that CEM is more appropriate for estimating panel data regression than FEM and REM.

Hypothesis Testing

Equation 1:

```
. reg z x1 x2
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Source	SS	df	MS	Number of obs =
Model	156.596258	2	78.2981291	F(2, 77) = 3
Residual	193.757234	77	2.51632771	Prob > F = 0.
Total	350.353492	79	4.43485433	R-squared = 0.
				Adj R-squared = 0.
				Root MSE = 1.

z	Coefficient	Std. err.	t	P> t	[95% conf. inter
x1	.0556044	.0102029	5.45	0.000	.0352878 .07
x2	-.0685488	.0139042	-4.93	0.000	-.0962356 -.04
_cons	6.104655	1.456131	4.19	0.000	3.205128 9.00

Equation 2:

```
. reg y z x1 x2
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Source	SS	df	MS	Number of obs =
Model	69.6373772	3	23.2124591	F(3, 76) = 63.93
Residual	27.5945766	76	.363086535	Prob > F = 0.0000
Total	97.2319539	79	1.23078423	R-squared = 0.7162
				Adj R-squared = 0.7050
				Root MSE = .60257

y	Coefficient	Std. err.	t	P> t	[95% conf. interval]
z	-.1199102	.0432889	2.77	0.007	-.033693 -.2061275
x1	-.0020637	.0045623	-0.45	0.652	-.0111503 .0070229
x2	-.0617082	.0060581	-10.19	0.000	-.073774 -.0496424
_cons	6.317546	.6130094	10.31	0.000	5.096632 7.53846

$$Z = 0.0556044X_1 - 0.0685488X_2 + 0.5674$$

$$Y = -0.0020637X_1 - 0.0617082X_2 + 0.1199102Z + 0.2950$$

The explanation is as follows:

1. The direct influence of the variable (LDR) on (NIM) is 0.0556044
2. The direct influence of the variable (BOPO) on (NIM) is -0.0685488.
3. The influence of other variables on (NIM) other than the variables (LDR) and (BOPO) is 0.56740.
4. The direct influence of the variable (LDR) on (ROA) is -0.0020637.

5. The direct influence of the variable (BOPO) on (ROA) is -0.0617082.
6. The direct influence of the variable (NIM) on (ROA) is 0.1199102.
7. The influence of other variables on (ROA) other than the variables (LDR), (BOPO) and (NIM) is 0.2950
8. The indirect effect of (LDR) on (ROA) through (NIM) is 0.0066673
9. The indirect effect of (BOPO) on (ROA) through (NIM) is -0.0073994

t-Test (Partial)

T Path Equation Calculate Probability

$$\text{Equation 1} \quad X_1 \Rightarrow Z \quad 5.45 \quad 0.000$$

$$X_2 \Rightarrow Z \quad -4.93 \quad 0.000$$

$$\text{Equation 2} \quad X_1 \Rightarrow Y \quad -0.45 \quad 0.652$$

$$X_2 \Rightarrow Y \quad -10.19 \quad 0.000$$

$$Z \Rightarrow Y \quad 2.77 \quad 0.007$$

The partial influence of independent and dependent variables is as follows:

- a. The variable (X1) has a calculated t value of $5.45 >$ the t table value, namely 1.991254. and sig. value $0.000 < 0.05$ then it can be concluded that X1 has an effect on Z
- b. The variable (X2) has a calculated t value of $4.93 >$ the t table value of 1.991254 and the sig. value is $0.000 < 0.05$, it can be concluded that X2 has an influence against Z.
- c. Variable (X1) has a calculated t value of 0.45 $<$ t table value of 1.991673 and a sig. value of $0.652 > 0.05$, so it can be concluded that X1 has no effect on Y.
- d. Variable (X2) has a calculated t value of 10.19 $>$ t table value of 1.991673 and a sig. value of $0.000 < 0.05$, so it can be concluded that X2 has an effect on Y.
- e. The variable (Z) has a calculated t value of $2.77 >$ the t table value of 1.991673 and a sig value of $0.007 < 0.05$, so it can be concluded that Z has an effect on Y.



F Test (Simultaneous)

F Equation Calculate Probability

Equation 1 **31.12 0.0000**

Equation 2 **63.93 0.0000**

Based on the table, it can be seen that the probability value of equation 1 is 0.0000 <0.05, so it can be concluded that variables X1 and X2 simultaneously affect Z. While in equation 2 the probability value is 0.0000 <0.05, so it can be concluded that variables X1, X2 and Z have an effect on Y simultaneously.

Coefficient of Determination (R2)

Adj R.Squared Equation

Equation 1 0.4326

Equation 2 0.7050

Based on the table above, it can be seen that the Adjusted R Square value of equation 1 is 0.4326 or 43.26%, this explains that variables X1 and X2 have an influence of 43.26%, on Z and the other 56.74% is influenced by variables outside the ones used. While in equation 2, the value is 0.7050 or 70.50%, this explains that variables X1, X2 and Z have an influence on Y of 70.50% and the other 29.50% is influenced by variables outside the ones used.

Sobel test

Equation 1

	Input:	Test statistic:	Std. Error:	p-value:
a	0.0556044	Sobel test: 2.46934028	0.00270013	0.01353624
b	0.1199102	Aroian test: 2.43695315	0.00273601	0.0148116
s _a	0.0102029	Goodman test: 2.50305399	0.00266376	0.01231268
s _b	0.0432889	Reset all	Calculate	

Based on the results of the Sobel test above, it can be seen that the p-value obtained is 0.01353624 (<0.05), so it can be concluded that variable X1 has an effect on Y through Z as an intervening variable.

Equation 2

	Input:	Test statistic:	Std. Error:	p-value:
a	0.0685488	Sobel test: 2.41492649	0.00340371	0.01573839
b	0.1199102	Aroian test: 2.37803107	0.00345652	0.01740536
s _a	0.0139042	Goodman test: 2.45359428	0.00335006	0.01414365
s _b	0.0432889	Reset all	Calculate	

Based on the results of the Sobel test above, it can be seen that the p-value obtained is 0.01573839 (<0.05), so it can be concluded that the variable X2 has an effect on Y through Z as an intervening variable.

4.2 Research Discussion

Companies that have Higher or lower ROA does not influence the company to take action income smoothing. That thing proves that ROA is not a determining factor in the level of income smoothing. Sarra & Alamsyah (2018) stated that profitability (ROA) has no effect on on income smoothing is likely due to changes in investors' views on company performance.

The effect of LDR on NIM

Research result show that the Loan to Deposit Ratio (LDR) has influence positive against Net Interest Margin (NIM) with coefficient of 0.0556. This means the more tall LDR ratio , the more big its influence in increase NIM.

In general theoretical , thing This in accordance with theory liquidity and management bank risk . According to theory liquidity , LDR describes how much large party funds the third one that succeeded distributed by the bank in form credit . The more high LDR means the more big distribution credit compared to with the deposit funds received by the bank. Conditions This can increase NIM, because the bank will accept more Lots income flower from loans given compared to cost incurred For pay flower on savings . However , the LDR ratio is too high. height can also increase risk liquidity .

The effect of BOPO on NIM

Research result show that BOPO has an effect negative against NIM with coefficient of -

0.0685. This means the more tall BOPO ratio, increasingly low NIM generated by banks.

In general theoretical, results This in line with theory efficiency and theory agency. BOPO is indicator efficiency bank operations, where the ratio This reflect how much big cost operational expenses incurred compared to with income operational obtained. Theory efficiency to argue that the more low cost operational, increasingly big the bank's ability to produce profit. high BOPO show inefficiency operational, which will lower NIM because more a lot of money spent For to finance bank operations, so that income flower clean reduce.

The effect of LDR on ROA

Analysis results show that LDR has influence negative that is not significant against ROA, with coefficient of -0.0021. This show that LDR increase does not always impact positive to profitability (ROA) of banks, even in a number of condition, ratio This Can reduce ROA.

This matter can explained through theory liquidity and profitability. High LDR ratio reflect height loans provided, however in condition certain, increasing LDR can causing the bank to experience problem liquidity, especially If credit given No managed with OK. If it happens credit stuck, the bank will bear losses, so that ROA decreases. This in line with the principle of trade-off between liquidity and profitability, where the increase bank liquidity through high LDR No always means improvement profitability.

The effect of BOPO on ROA

Research result show that BOPO has influence negative significant against ROA, with coefficient -0.0617. This means increase in BOPO direct will lower ROA.

According to theory efficiency and theory agency, high BOPO reflect inefficiency in management cost bank operations. When the costs operational increase more fast than income operational, profit margin will eroded, which has an impact negative on bank profitability, as measured through ROA. In theory agency, thing This Can happen Because

problem agency where the manager No manage source power bank effective, so that increase cost operational.

The effect of NIM on ROA

Study This show that NIM has influence positive significant against ROA, with coefficient of 0.1199. This is show that the more the higher the NIM, the more The ROA obtained by the bank is also high.

This result in accordance with theory management finance banking, which states that NIM reflects the bank's ability to manage asset productive. The more high NIM means the bank is able produce income flower cleaner more tall from activity loans and savings, which in the end increase bank profitability, as measured with ROA. Theory This support argument that efficiency in management assets productive is key For increase performance bank finance.

Influence No Direct via NIM

The study also found existence influence No LDR and BOPO directly to ROA via NIM: Influence No direct LDR to ROA through NIM of 0.0067. Influence No direct BOPO to ROA through NIM of -0.0074.

Influence No direct This show that NIM plays a role as intervening variables that strengthen or weaken connection between variables and ROA. In context this, the result the can explained through theory mediation, where NIM works as variable intermediary that strengthens the influence of LDR and BOPO on ROA. NIM is higher tall can compensate impact negative from high LDR and BOPO to profitability (ROA), but if NIM is low, the impact negative from high BOPO will the more to worsen bank profitability.

5. Closing

5.1 Conclusion

Based on the findings of this study, it can be concluded that the Loan to Deposit Ratio (LDR) has a significant positive effect on the Net Interest Margin (NIM), while the Operating Expenses to Operating Income ratio (BOPO) has a significant negative effect on NIM in

conventional banks listed on the Indonesia Stock Exchange during the period 2014–2023. This implies that an increase in LDR tends to enhance NIM, whereas an increase in BOPO tends to reduce NIM.

With regard to Return on Assets (ROA), LDR was found to have an insignificant negative effect, while BOPO demonstrated a significant negative effect. Meanwhile, NIM was shown to have a significant positive impact on ROA. These results highlight that operational efficiency, as reflected in BOPO, has a stronger and more direct influence on bank profitability compared to LDR.

Furthermore, the study identified the **indirect influence** of both LDR and BOPO on ROA through NIM as an intervening variable. This confirms that NIM plays a crucial mediating role in linking liquidity and operational efficiency with overall bank profitability.

5.2 Suggestions

1. **For Bank Management:** It is recommended that banks prioritize efforts to improve **operational efficiency** by minimizing unnecessary expenses, thereby enhancing profitability.
2. **Credit Optimization:** Banks should continue to optimize credit distribution, while maintaining prudent risk and liquidity management, to ensure that higher LDR ratios contribute positively to NIM without increasing liquidity risk.
3. **NIM Monitoring:** Net Interest Margin should be carefully monitored and managed, as it significantly influences profitability and mediates the effects of other financial ratios.
4. **For Further Research:** Future studies are encouraged to include external macroeconomic factors such as inflation, interest rate volatility, and regulatory policy shifts that may influence financial performance.
5. **Digital Transformation Consideration:** Given the rise of digital banking and fintech, upcoming research could examine how digital efficiency metrics mediate similar financial performance relationships.

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